Mobile Tourist Recommendation Systems Based On Tourist Trip Design Problem For Indonesia Domestic Tourist, An Exploratory Study

Indri Hapsari
Department of Industrial Engineering, University of Surabaya, Surabaya, Indonesia
(*indri@staff.ubaya.ac.id*)

Abstract - **Tourism, as social activity, consists of many interactions with other people like asking suggestions from friends and travel agents, connecting with the transportation and accommodation provider, and sharing the experience to others. Face-to-face interaction now is changing because Internet supports it by social networking systems. Tourism information technology is growing very fast; they are not only giving the information, but also providing the recommendation for a tourist personally. Travel recommendation system is using this technology in helping travelers to choose their destination, accommodation, and activities at the destination. Many researches have tried to capture tourist profiles, developed the route algorithms, designed recommendation systems and mobile applications. Indonesia has a big potential in tourism industry. There are many various destinations for tourist, and Indonesia has a lot of domestic tourist along with revenue increasing in middle class society. This paper will denote the previous researches in profiling tourist characteristics and preferences continue with progress in algorithms and mobile recommendation systems, then the last is a mobile tourist recommendation systems model that compatible with Indonesia's condition.**

Keywords - **tourist trip design problem, travel recommendation, recommender system, tourism**

I. INTRODUCTION

Tourism as a tertiary needs has a trend to increase now, accordance with the increasing of people earning. While tourism usually relies to foreign tourist, nowadays domestic tourist exceed foreign tourist, in number of people and expense. Based on Laporan Kinerja Kementrian Pariwisata [1] in 2014 from Ministry of Tourism and Creative Economy (now Ministry of Tourism), showed a significance difference between foreign tourist and domestic tourist. In 2015, there were 11.2 million foreign tourists and 259 million domestic tourists. They gave foreign exchange to Indonesia 10.69 billion and it needed more resources in tourism, which increased nation's economy. Total domestic tourists expense in Indonesia was increasing, from 137.91 trillion in 2009 to 177.84 trillion in 2013 [2].

However, none of those numbers was influencing the Indonesia's rank in the world. Compare with countries in neighbor, the competitive power of Indonesia still lower even the potential is better. Based on Word Economic Forum [3] in 2015, Indonesia had rank 50th in the world and 11st in Asia-Pacific; with the most potential power was competitive price. Singapore's rank was 3rd, Malaysia 7th and Thailand 10th. Special note in that list stated that mobile network has already reached all the area in Indonesia, indicated information access will be very easy to do, no matter wherever the tourist will be. In Indonesia according to Badan Pusat Statistik data [1], tourism industry can compete with the natural resources as the main commodity like crude oil, natural gas, palm oil and wood. This condition must be upgraded to increase the rank and foreign exchange revenue.

Tourism competitive factors that already discussed in National Tourism Conference [4] in 2015 showed that some factors were decreasing. For example is national perception that became some researches topics. In Bursan [5], Dwiputra [6], Oktaviani and Riyana [7] and Rahajeng [8] showed that one of the reasons was there is a few information that can be used by the tourists in arranging the itinerary. The technology infrastructure that was going better actually can support faster and more accurate information for the tourists. Rearrangement of information system network infrastructure became strategic target to prepare the facilities for the public use.

Until this time, the information for the tourists has less attention, especially for the characteristic of domestic tourists. Warman [9] stated that domestic tourists were profuse and like to shop, like to go in-group, and like the popular destination. But for the opposite, there is a good growth for the tourists who like a single trip or small group, and try to find out a new destination. The social-demographic factor, geographic and psychographic domestic tourist will affect to tourist profile, and it will be a guidance to predict the length of time in exploring tourist destination. It is the time for Indonesia tourism become king in its country. Marie Elka Pangestu as the previous Minister of Tourism and Creative Economy said domestic tourists has spent more than 8 billion US dollar abroad. We can imagine if only a half of the expense is used in Indonesia tourism, the foreign exchange will be higher. Many studies have already done about obstacles to enjoy Indonesia tourism destination, and many improvements has done. However, to increase the tourists' interest must be started by easiness to get the destination information, and then follow by trust building for domestic tourists to love the potential of their country.

For years, tourists in Indonesia usually took a travel agent to arrange their itinerary without option to change the destination, route or schedule. They have courage to go in group without travel agent advices, but still they choose the popular destinations, because of influence

from many people and information about that place. Nowadays, many independent tourists have a freedom to decide what destination they will visit even though it is not popular. Based on the information that very easy to get from the Internet, tourists have a lot of options to choose, and it will depend on their characteristics and preferences. These alternatives must be fit with the constraint, such as their limited time. The time window arise because tourists must be back soon to their origin, and it will relate to the money they will spend on their holiday.

Tourists usually use Google Map to arrange their itinerary, and predict the time. Unfortunately, until now Google still don't have ability to arrange the schedule. Google only can mark the favorite destinations by the star symbol, after the tourists have enough information about this place from the searching engine. The entire favorite place can be collected in their own map. Then the tourist can predict the distance and the time from one place to another place, trying to find what arrangement that make their route will efficient. For example, if from point A to B need an hour, and from A to C need 2 hour, they will choose A to B first, and then B to C based on the time efficiency. The problem arises when they don't check the time from A to B, and B to C is more than the time from A to C and C to B. This problem was happened because it is difficult to arrange the route as an integrated journey.

Tourists need to arrange all the destinations become a trip planner because they have a very limited time to enjoy the journey. Beside their limitations, the destinations also have other limitations like total expense and the opening hour. For certain destinations, they have special program that need specific time to show. Other considerations are the road condition in Indonesia that is very unpredictable, along with the unfamiliar public transportation. Tourists must arrange the trip planner carefully and often iterative to satisfy their willing to visit all their favorite destinations, with all the conditions and their limitations.

Recommendation Systems [10] is a web application that can help users to predict potential item. In tourism industry, recommendation system will give good recommendation for tourists, so they do not need to search, select and evaluate the route. A travel recommendation system allows users to choose their holiday while sitting in front of a computer. A simple user interface provided by the recommendation system offers an interactive and simple means of communicating with the system. These systems want to make shorter interaction time by reducing the time needed for visiting various Web sites to gather information [11]. Today the recommendation system development leads mobile users to access easily the Internet and the more flexibility with their mobile device. The existing systems also more personal, because they can give more accurate personalized tourist recommendations that capture several parameters.

This article presents the state-of-the-art that has contributions in the Indonesia tourism industry field. It will start with the literature review that explains about scope of the recommendation system model, previous research in algorithm to create the itinerary, and the existing mobile applications. This review will be the base of model designs with some adjustment related with Indonesia conditions. It also highlights promising research opportunities with respect to mobile recommendation system employed in tourism.

II. LITERATURE REVIEW

Tourism [12] becomes a major area in academic, government, industry and public concern. As the largest industry, tourism is huge in size of people traveling, people who work in this industry, and the money spend. Tourism impact significantly to the people's lives on those places. The World Tourism Organization's [13] predicts that by 2020 international arrivals will reach nearly 1.6 billion, which 1.2 billion is for intra-regional and 378 million will be long-haul travelers. By 2020 the top three receiving regions will be Europe (717 million tourists), East Asia and the Pacific (397 million) and the Americas (282 million), followed by Africa, the Middle East and South Asia. The WTO in 1991 recommended that an international tourist be defined as:

A visitor who travels to a country other than that in which he/she has his/her usual residence for at least one night but not more than one year, and whose main purpose of visit is other than the exercise of an activity remunerated from within the country visited.

Similar definitions were also developed for domestic tourists, with these having a time limit of 'not more than six months' (WTO 1991). As Hall and Page [14] noted including same-day travel is:

'Excursionist' category in technical definitions of tourism makes the division between such categories as recreation and tourism, or daytrips and tourism, even more arbitrary, and they observed that there is increasing international agreement that 'tourism' refers to all activities of visitors, including both overnight and same-day visitors.

According to France [in 13]:

It is now commonly accepted that a tourist, as opposed to a day visitor, is someone who spends at least 24 hours away from home even though both categories of visitor might engage in similar activities. Although there is no generally accepted maximum time-limit for a tourist visit, it is normally accepted that a tourist is away from home for a relatively short period.

Destination [15] is geographic area where people can visit and experiences (see and feel). Destination is a soul and develop machine for society, or support the economic

growth. Destination has various places, from beauty nature to fantastic scenery. Tourism destinations acquire various attractiveness, facilities, and access. Experience showed without collaboration, coordination and sustainability the destination would not grow.

Tourist attractions [16] consist of all those elements of "non-home" place that draw discretionary travelers away from their homes. They usually include landscapes to observe, activities to participate in, and experiences to remember. Tourist attraction is a system comprising three elements: a tourist, a sight, and a marker. This systemic definition does not apply to all forms of tourist attractions, but refers to the most common and obvious, involving sightseeing. The tourist attraction must be motivated by a desire for novelty and education.

Various environmental categories of actual or hypothetical places can be listed with their attributes and classified with varying degrees of scope and detail [Lew in 16]. The natural environment includes topography, landscape, flora and fauna. The built environment encompasses factors such as cityscape, specific buildings, monuments and archaeological sites. The socio-cultural environment includes ordinary and famous people, language and dialect, customs, music and dance, cuisine, historical artifacts and collections, and artistic objects and collections. The technological environment includes applications of science, in incidental or staged displays. The Schmidt's typology [in 16] structured under five heading of emphasis: geographic, social, cultural, technological, and divine. Attala and Nasr [17] categorized the tourism area into some components of culture, sun and beach, nature, sports, MICE, themed, travel services, and lodging and food.

Tourism Informatics began with the first air ticket booking system in 1950s by the American Airlines. Since then the information systems use in many tourism activities like booking tickets and hotels by Internet. They can do it personally and custom to their need. All those activities have purpose to support their tour planning better. Then it grew to the recommendation systems that can recommend the tour planning fit with the tourist preferences. Some of those systems capture information from many websites and link this, show the visualization in 2D, 3D and video clip. Travel Recommendation System has been developed for about a decade now. This type of recommendation system will accept inputs from a traveler, provides some recommendations, for possible tours that match the users' input information [18]. Using multimedia technologies, the system will be completed with a chosen destination, transport, and accommodation. It will grow to develop of Visual Travel Recommender System (VTRS) [19].

Gavalas et al. [10] has surveyed certain papers with the mobile tourism recommendation systems topic. They defined recommendation systems as a system that not only gives enough information, but also gives recommendation for the user. This system will help the user to reduce or avoid the search and select activities. Most of the recommendation systems now are using internet because of the low cost, need less time, can be accessed anywhere, and always update. The way how recommendation system work is by using user characteristic and preference, and then the system will use it as a base to recommend something. Related to tourism business, the recommendation systems will help the tourists to decide what destination that they recommend to visit, regarding with their characteristic and preferences. If they must face with a lot of alternatives, this system will help them with less effort and less time.

Gavalas et al. [10] also made some groups of all the research from a survey. The first group is about point of interest (POI) recommendations. These recommendations are including the opening and closing time, easy to access, flexible to visit, weather, transportation mode, user mood and social environment. It has various visualization starts with text and image, sound and video, 2D and 3D, Virtual Reality Modeling Language, and augmented reality. It is also using Geographic Information Systems (GIS) to predict the location accurately. The third group is collaborative user-generated contents and social networking services for tourist. This feature is using the concept of Web 3.0 about user-generated content. Therefore, the tourist will give the information and the recommendation systems will update. This feature is either has less responsibility of the contributors or make user unfocused with the POIs. They will be very busy to communicate and relate with other user. Other consideration is this system can operate on the offline mode. Indonesia's Internet networking is not good enough, centralized only in Java. Therefore, it is very difficult to preserve the connection, even though we need it very much. Running in the offline mode could be a good idea, while if the system is connected to Internet it will update automatically. Fourth group will show about routes and tour recommendation. These routes are coming up based on current location, available time, tourist's preference, and multi-days. Gavalas et al. explained more for the route algorithm with all the strongest and characteristic of each algorithm in their next research [20].

Based on Stabb et al. [21], the recommendation system can be classified into four types. The first type is content-based, which the system will make a recommendation based on the user profile and product information. The second type is collaborative-filtering, it use the feedback or review to show the information that suitable with user's need. The third type is knowledge-based, by combining the knowledge about the user and the product, so it can predict the user's need. The last is hybrid that combines two or more methods to satisfy the user, for example like artificial network. This category is almost the same with Gavalas et al. research [20].

Gavalas et al. [20] made some group to show where the algorithms are modified. The focus is on Tourist Trip Design Problem (TTDP), while it can be divided into two groups, single tour and multi tour. Single tour is a tour that is developed from a network and the nodes relate to profit and cost. So the purpose is to maximize collected

profit while minimize travel cost. For the first, the method's name is Traveling Salesman Problem with Profits (TSPP) then continues with multi-objective vending problem. Three methods of TTDP have objectives to maximize collected profit and minimize travel cost, namely:

1. The Profitable Tour Problem (PTP) [22], try to maximize the revenue minus the travel cost to get the profit.
2. The Prize Collecting TSP (PCTSP) [23] will minimize the travel cost with total tour profit is not smaller than given value.
3. The Orienteering Problem will recommend a tour that maximizes the total collected profit while maintaining the travel cost under a given value. The OP more closely formulates the single tour version of the TTDP than the other two single-criterion TSPP variants. OP is developed for the first time by Tsiligirides [24] and growth regarding to the tourist requirement.

Orienteering first comes as an outdoor sport that has some place with the score. Player will use compass and map to visit some places and get the points. Player tries to maximize their score with limited time, by visiting any places that contain more points. The distance and travel time become known quantity, and that is why this game needs a good route. His own choice must be closed to start and finish point, then pick up a higher point. This algorithm becomes an extension of traveling salesman problem (TSP) with the difference is in this method they don't need to visit each place. Tsiligirides approached two heuristic for the orienteering problem, divided into stochastic algorithm and deterministic algorithm. The stochastic algorithm is using Monte Carlo techniques to develop many alternatives of routes and select the best one.

Based on Gavalas et al. [20], multiple tours tried to collect the profit by using some vehicles with each capacity. For example, like Vehicle Routing Problem with Profits (VRPP) [32] and Team Orienteering Problem (TOP, the Prize-Collecting VRP (PCVRP), the Capacitated Profitable Tour Problem (CPTP), and the VRP with profits and time deadlines (VRPP-TD).

For the current travel recommendation systems, Gavalas et al [10] said there are two most popular recommendation systems for tourism and travel; they are www.TripMatcher.com and Me-Print™ that used by Travelocity [11]. Some of them have free access such as citytripplanner.com [25] or m-trip.com. Both of them contained choice of destination, cover tourists preferences and profiles, and can give recommendation like the route and the time. The information that must be input is days, preference, start or end point. They used visualization on map to help the user predict the route. The trip matcher combine statistic from past user with a prediction computed as weighted average of importance assigned by user account. The system will give advice based on their interest and browsing pattern. It will use contextual filtering and attribute based collaborative filtering. The other recommended system is vacation-coach [26]. It relies three important components like personalized travel advice, intelligent prolong, expert knowledge and robust advice engineering. It will exploit user profile like unique lifestyle, leisure preferences and arrange it using priorities and interests.

Developing the personalized electronic tourist guides, there are three functions need in those guides. The first is recommendation based on tourists' profiles, the route generator, and the last is customization. For route generator, it needs tourists' data like days duration, opening hours from the POIs, and transportation data. Then for the customization means user can modify, add or remove, and reorder the route. The extension of this guide is website or mobile application.

For all the recommendation system that already existed and supported the tourist, there is a good progress in accuracy so there are bigger probabilities the user will accept the recommendation. However, there are some limitations such as it only deals with the POIs selection, not followed by nearby services. The nearby services are like restaurant, hotel or tourist attraction. Another challenge is how to visualize the planned holiday that make tourists understand the suggestion easier.

III. MODEL DEVELOPMENT

The WTO data shows that Indonesia will get much more tourist in the 2020, and the intra-regional tourist, whom we can say: domestic tourist will dominate the total tourist who visits the destination in Indonesia. For this good progression now or later, there is a requirement for this type of tourist to arrange their itinerary personally. Even tough most of Indonesia's traveler will use travel agent for holiday abroad, for their own country they dare to explore by themselves. The recommendation system will help them to make a better plan.

I will divide the model into 3 steps, the first is the tourist, second is the tourist attraction or destination, or what I call POIs (point of interest), then the last is the environment. The tourist in this model will focus to the interregional tourist or domestic tourist, as we know that the number will be increasing very fast compare to the international tourist. It also considers about the level of revenue in Indonesia, not many people can travel abroad, so they will travel to other cities or provinces in Indonesia. The tourist factors are the characteristics (social-demographic, geographic and psychographic) and preferences (favorite POIs, time budget, money budget). The second factor, POIs, will be collected for the top POIs in entire area in Indonesia, covering from certain categories. Those categories are culture (e.g. palace, museum, festive), nature (e.g. beach, mountain, lake), sports (e.g. paragliding, wall climbing, bungee jumping), MICE, cuisine (e.g. restaurant, street, café), shopping (e.g. wholesale center, night market, traditional market), and theme park (e.g. Dunia Fantasi, Jatim Park, Wisata Bahari Lamongan).

Some hypotheses must be proven to support this model because I try to capture Indonesia's tourist

uniqueness. Those hypotheses can be grouped into some categories. The first category is the relationship between tourist profile and their favorite categories. There is assumption that a specific gender of tourists will tend to choose certain categories. For example, woman will choose favorite categories like shopping and culinary. There is also another assumption that older tourist will choose more relaxed categories like culinary and scenery. To support this assumption it needs to be proven statistically by t-test. The hypotheses are:

H_1: There is difference between gender and categories
H_2: There are differences between group of age and categories

The second categories try to capture the tourist limitation. Based on the previous research, two limitations must be considered to get a good recommendation. The first constraint is time budget, and the second is money budget. While do the traveling, tourist has limited time to do it, because they must back to their daily routine, and it is related with the money. Because each tourist has different revenue and percentage of holiday expense, it will influence the spending cost for the trip. Both of those limits, it is become an interesting research to find out which one is more important. Even tough there are some limitations; the allowance can be happened if tourist think the trip is worth it to implement. The 20% allowance becomes the limit if the time or cost is underestimated than it should be.

H_3: Time budget is more important than money budget
H_4: Tourist is willing to add more time if the recommendation is 20% more of their budget
H_5: Tourist is willing to add more money if the recommendation is 20% more of their budget

The third category is about tourist type. There are two types of tourist, the explorer and flash traveler. Those types will affect to the service time or time to stay in a POI. The hypotheses will prove does the explorer's service time will be longer than flash traveler. Explorer is tourists that have interest to explore POI, enjoy the time when they are there, and have a tendency to skip the time. Meanwhile the flash traveler usually a social media activist, so all their activities is for their existence on internet. They will use their time in POI to take many pictures, upload it, then leaving the POI to find another spots. Another hypothesis is the service time for the favorite categories will be longer than not favorite categories. It is interesting to find out both of the tourist types will happen the same thing or not.

H_6: Explorer tourist has longer service time than flash traveler tourist
H_7: For explore tourist, service time in favorite categories will be longer than not favorite categories
H_8: For flash traveler tourist, service time in favorite categories will be longer than not favorite categories

The last category is the influenced of tourist preferences to the POIs. The first assumption based on the opinion tourist will stay longer in their favorite POIs, but for how long they will stay. Another 20% allowance will be added to cover this hypothesis. The next hypothesis is the larger the POIs space, the longer tourist will stay. This assumption is not considering about the favorite POIs because it is already covered in the previous POIs, and this hypothesis is not considering the interdependency between them.

H_8: Tourist will stay longer in their favorite POIs
H_9: Tourist will stay longer in larger space of POIs

This model must cover the change that maybe happened. Even tough the optimal route will be produced, tourist as the user will get more customize result. They have an option to choose their starting point, for public transportation terminal or hotel. This model also covers their preferences, for example, they can describe what type of tourist they have, a flash visit or enjoyment visit. The limitation will be covered by asking their limited time and budget. It will influence for the algorithm of the system will be single day or multi days. The multi-days travel trip also becomes one of the challenging modifications. While traveling inside the city is not attractive anymore, the domestic tourist can create a plan to visit several cities near the first POIs. This decision brings the consequence: it takes a longer time, or maybe a couple of days. How to generate a longer trip planning in a longer time becomes this model's consideration. The opposite of this spirit is tourist can limited their time to visit, and wait for the best recommendation trip planner regarding of their limitation.

Herzog [27] explained about Tourist Trip Design Problem (TTDP) as extension of the Orienteering Problem that used in this model. An Orienteering Problem is a system score, which collects the point for the user assign in every location in a sequence. The goal is to maximize the amount of the points of the selected locations while still accommodate the limitations. The Orienteering Problem (OP) It is also known as the selective Traveling Salesman Problem, the knapsack problem, the maximum collection problem and the bank robber problem [28] The optimum method can not be used because all possible combinations will take a longer time, and the result could be infeasible. Therefore, the option is using the heuristic procedure to run the algorithm. The heuristic method will give more efficient and flexible result by considering the option and customization from the user.

TTDP in a static network based on the starts point, destination point, and time budget without involving tourist trip design problem in a dynamic time dependent network. Starting point for domestic tourist could be from train station, airport, terminal bus, or hotel. Destination points are all the POIs. In tourism, time dependent [29] is related to the public transportation schedule or waiting for a shuttle. Regarding to POIs in Indonesia, most of them

only offer the static opening hours, without time and price discrimination. In each POIs and tourist preference, they have average visiting time. Those POIs only can visit once. The range of time can be predicted from the customer characteristic and result on H_8 *and* H_9. The objective of this problem is how to select a route between the POIs to maximize the total utility of tourist trip within a given time budget. The money budget could be considering if the H_3 result is accepted. Giving the points to each POIs [30] can be obtained using information retrieval or tourist identification. Tourist often decides trip plan in terms of the schedule, set the time budget to be fixed and constant.

The baseline combinatorial optimization problem for TTDP is the Orienteering Problem (OP) [31]. In the OP, OP can be formulated as follows: Let G = (V, E) be an edge-weighted graph with profits (rewards or scores) on its nodes. Given a starting node *s*, a terminal node *t* and a positive time limit (budget) *B*, the goal is to find a path from *s* to *t* (or tour if *s*≡*t*) with length at most *B* such that the total profit of the visited nodes is maximized.

The objective of the problem [28] is to maximize the total utility (1). p_i is for tourist preference value for node V_i, while $x_{ij}(t)$ is 1 or 0, depending of the edge e_{ij} entered at time t or not. T is for total time budget for this trip. V and E is time dependent network. S(i) is set of successor nodes of nodes V_i. Time will start on t_0. Constraint 2 and 3 formulated about flow conservation constraints. P(i) is set of successor nodes of nodes V_i. Constraint 4 will ensure that every POIs is visited at most once. Constraint 5 and 6 guarantees that if one edge is visited in a given tour, the arrival time of the edge following node is the sum of the preceding arrival time, visiting time and the edge travel time. v_t is stay time on node V_i. Constraint 7 is the start time and end time constraint. If t_0 is starting time, t_i is arrival time at node V_i. In constraint 7 t_0 equal with t_1 means V_1 is the starting points so the time start from there. Constraints 8 and 9 are the variables constraints.

Souffriau et all. [32] said the OP may be used to model the simplest version of the TTDP wherein the POIs are associated with a point for user satisfaction and the goal is to find a single tour that maximizes the point collected within a given time budget. Extensions of the OP have been successfully applied to more complex model of the TTDP.

The team orienteering problem (TOP) represents extension of the OP to multiple tours. The TOP with time windows (TOPTW) considers visits to locations within a predefined time window. The time-dependent TOPTW (TDTOPTW) considers time dependency for estimating the time required to move from one location to another and suitable for modeling multi-modal transports among POIs.

This model will use the multi orienteering problem with time window because POIs in Indonesia still in various and static opening hour, while tourist has time budget to explore all the favorites POIs. The algorithm

$$\max \sum_{t=t_0}^{T} \sum_{i=2}^{n-1} \sum_{j \in S(i)} p_i x_{ij}(t) \quad (1)$$

$$s.t. \sum_{t=t_0}^{T} \sum_{j \in S(1)} x_{1j}(t) = \sum_{t=t_0}^{T} \sum_{i \in P(n)} x_{1n}(t) = 1 \quad (2)$$

$$\sum_{t=t_0}^{T} \sum_{i \in P(k)} x_{1k}(t) = \sum_{t=t_0}^{T} \sum_{j \in S(k)} x_{kj}(t), \forall k = 2,\ldots,n-1 \quad (3)$$

$$\sum_{t=t_0}^{T} \sum_{j \in S(i)} x_{1j}(t) \le 1, \forall i = 2,\ldots,n-1 \quad (4)$$

$$\sum_{t=t_0}^{T} \sum_{i \in P(j)} \left(t + t_{ij}(t)\right) x_{ij}(t) = t_j, \forall j = 2,\ldots,n \quad (5)$$

$$\sum_{t=t_0}^{T} \sum_{j \in S(i)} t x_{1j}(t) = t_i + v t_i, \forall i = 1,\ldots,n-1 \quad (6)$$

$$t_1 = t_0, t_n \le T \quad (7)$$

$$t_i > 0, \forall i = 1,\ldots,n \quad (8)$$

$$x_{ij}(t) = 0,1, \forall e_{ij} \in E, \forall t = 1,\ldots,T \quad (9)$$

will group the POIs into some routes, and it could run in one day with multi-routes or multi-days. There is no dependent time between the POIs and the transportation. The public transportation planning is not well prepared so it is very difficult to predict the timetable will be followed accurately or not. The assumption in this model is tourist will use a private car for exploring one area. This algorithm will be validated by proving the algorithm result is feasible, then by comparing algorithm result and computer model result.

For this model, I prefer to use the collaborative filtering to give the tourist recommendation. The second type is suitable because the system will record the user needs at that time, threat it as the preference, and combine with the user's profile, so the system can give good information. The result is not only about the POIs information, but also the route arrangement that the tourist can follow in operational. For input data, it needs information from the POIs like opening hours, indoor or outdoor, ticket price, type, content, space and distance. Other information is the environment around POIs. The environment is like the access of transportation and weather, related with the position and the season at that time. Tourist preference and limitation is included their favorite POIs, time budget, money budget and the type of information that they need from the POIs. From the data processing the model can select what information that must include in the user interface, and predict the type of tourist, between the explorer (need more time to stay) or flash traveler (only need a few time to enjoy the place). The processing data become input for the algorithm and give result for the personalized route recommendation. However, for more applicable route, it is still customize from the tourist. For example, they can remove or add some POIs, can rearrange the route manually, can add or reduce the visiting time in each POIs. The model can be seen in figure 1.

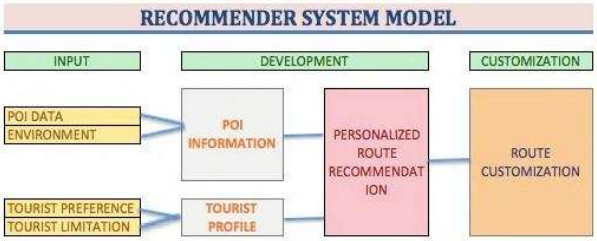

Fig. 1. Recommender System Model

For the visualization, Google Map is the popular application for Indonesia people. People in Indonesia usually use Google Map as their guide to go anywhere, it is free, easy to use and can access easily to the smart phone. The visual itself will follow Google Map Technology like Google Street View and Google Earth. Using the Google Map application also gives the user benefit, which is to find out nearest tourist service recommendation. The recommendation is including restaurant, hotel and transportation. If we relate the recommendation systems into Google Map, this problem will be solved easily because Google Map can show the users nearby supporting facilities. For restaurant or hotel recommendation that were suggested to include in this system, it can not make sure to us that it is very important. Usually the tourist has already decided before they do the traveling. Furthermore, Google Earth is very good to show the user what around their location, and tourist can choose it freely.

To realize this model, there are some steps to do in sequence in figure 2. Those steps become guidance and can expand to the website or mobile application. The algorithm recommender system and the way to visualize will be growth because it must be done step by step. Starting with the basic one, I hope they can approach closely to the perfect ness. For algorithm, it can start with the one day routing, then continue to multi days. For the first using one constraint like time budget or money budget, then continue with both of them. The recommendation system starts with creating the system, and then it can be customized so the recommendation will be modified. Website is the simple way to share the benefit to the user, but using mobile application will be better because it can run faster, easier and more reliable. For location, it can be used specific place and just depend on the single input, but for the next it must consider the web 3.0, where users can share their experience and can be used by other users. The location must be dynamic to cover this. For the visualization the better one is text and map than text only, continue with the integrated with Google Map rather than distance matrix, and combine with the weather info.

V. CONCLUSION

Indonesia needs a special treatment to raise the tourism industry. Based on the data there is a significant growth in domestic tourist, and this phenomenon becomes potential strength. The problem is how to support this interest to a valuable activity. Besides rearrange the infrastructure, it is also needed to deliver good information to the tourist. The information they need is for the POIs, the environment and considering the tourist profile, like their preferences and limitation. Modification of algorithm Orienteering Problem will be developed to produce a recommendation route that fulfills the tourist need. This modification will be needed because Indonesia condition is different with other country, either the POIs or the tourist. So start from the algorithm, it must be changed to make it suitable for the real condition. The recommendation system will consider the easiness access for the domestic tourist and absorb the local content for user-friendly.

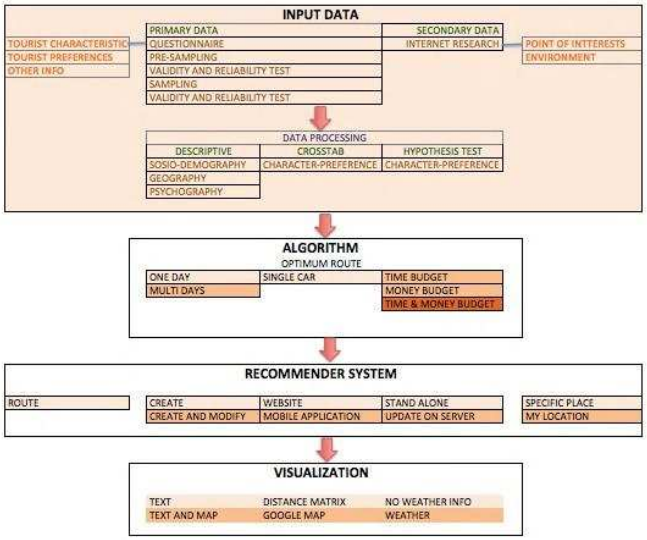

Fig. 2. Research Flowchart

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